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SATELLITE NETWORK MANAGEMENT SYSTEMS

by

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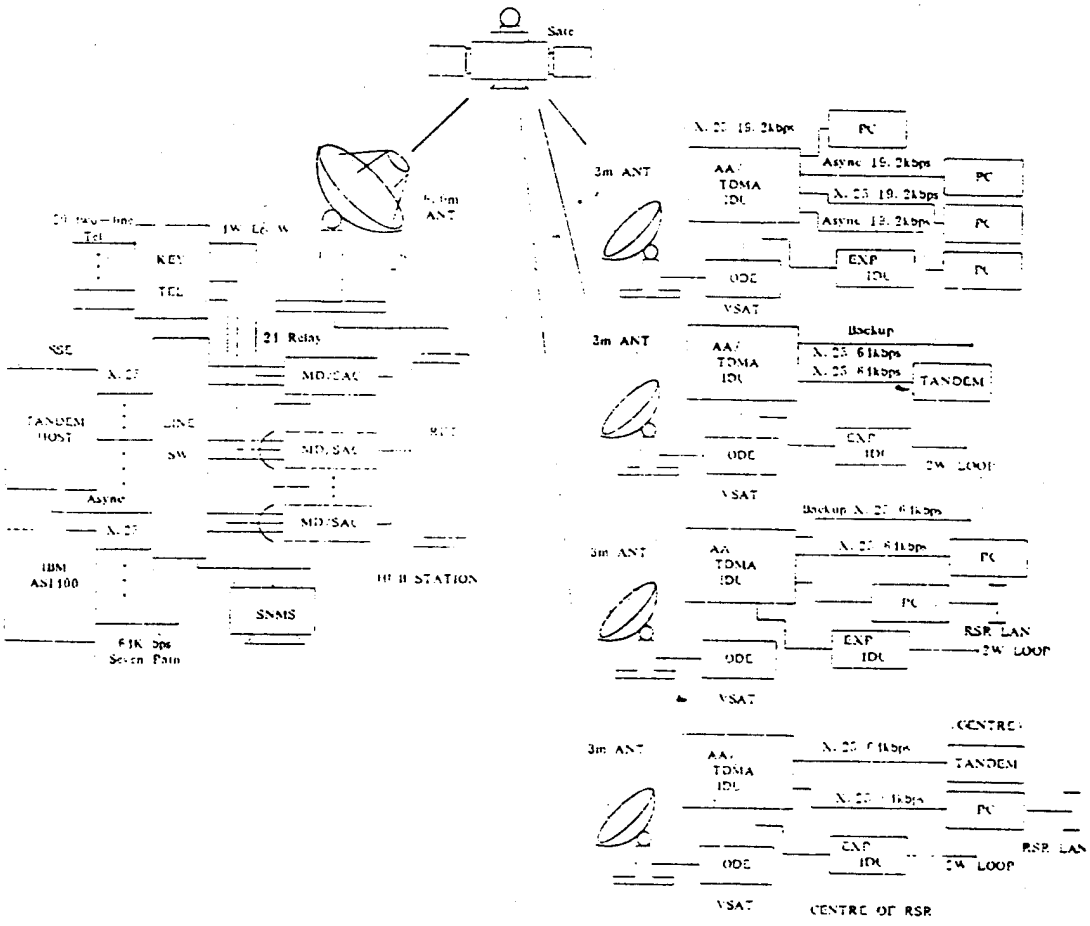
ABSTRACT

Satellite network management systems (SNMS) are the primary component of VSATs. They perform the entire network management function. The network system management function primarily includes three parts: The administrative, the operational and the management. The Shenzhen Securities Satellite Communications Systems built by the China Space Technology Institute has been formally put on line. It uses the NEXTAR AA/TDMA imported from Japan's NEC. This article attempts to use a discussion of the SNMS system functions, hardware structure and software structure to further describe the significance, characteristics and uses of the SNMS, describe the technical characteristics of the SNMS as well as better assist engineering technicians understand the concept and technical characteristics of the SNMS.

1. Introduction

The Shenzhen Securities Satellite Data Communications Network, built by the China Space Technologies Institute, has formally been put on line and is operating excellently. This network imported NEC corporation's NEXTAR AA/TEMA from Japan. The net is a star net. This a VSAT system is composed of a main station in Shenzhen with a six meter antenna and 1000 substations. The system is shown in Figure 1.

Fig. 1. Overall structure of satellite network



As for the Shenzhen Securities Exchange (SSE), the main computer (TANDEM) through X.25 agreement, connected with SAC at a rate of 64kbit/s to transmit data: Through ASYNC agreement, at a rate of 19.2kbit/s it was connected to SAC to transmit broadcast data.

As for The Shenzhen Securities Registration Company (SSR), the primary computer (AS400) through the X.25 agreement, was connected to SAC at a rate of 64kbit/s.

The SSE substation has four data ports. One is used to receive broadcast from the main station, the second is used to exchange data back and forth, the third was used by the registration company and the fourth was used as a back up for the other three. The rates are all 19.2 kbit/s.

The SSR substation has two data ports, both of which are V.35 port 64kbit/s rate and X.25 agreement. One is a primary and one a back-up, and they cannot both be used at the same time.

The primary station can receive 10,000,000 transactions a day from substations, with each stroke 60 bytes. The primary station can also deliver the trading results of 10,000,000 transactions a day to the various substations around the country with 85 bytes per transaction. Results sent to substations are either timely or comprehensive. In addition to conducting these transmission missions, this communications network is also able to use its remaining capacity to perform other transmission tasks such as registration and electrical transmission of newspaper proofs. Some substations possess encrypted voice communications capability, and substations can double-skip communicate with other substations.

The satellite network management system is referred to as SNMS. It is responsible for control and management of all network services and operations. Its functions primarily include statistics and management of work load, diagnosing malfunctions and monitoring, statistics of breakdowns and printouts of incidents. Because the SNMS functions are so strong, the system can be expanded and equipment exchanged extremely quickly and easily, thus greatly reducing the amount of maintenance. At the same time it can achieve on line processing, ensuring no break in user operations.

We will first present a general introduction of the overall

concept of the auto- adapting/time division multiplex multiple address (AA/TDMA) used by this network to provide scientific and technical personnel with a preliminary understanding. In view of the fact that the SNMS plays a major role in the VSAT satellite communications system, we will stress the description of the SNMS system functions and the structure of the hardware and software, and then further describe the characteristics, significance and uses of the SNMS. We will also discuss the characteristics of the key technology in the SNMS in order to help scientific and technical personnel to better understand the VSAT network concept and its technical characteristics.

2. Auto-adapting/time division multiplexing multiple address (AA/TDMA)

The AA/TDMA entry mode can allow for both real time and large handling capacity at the same time. When the data volume is small, it can be sent quickly all at once. When the volume is large, it can first send one transaction adding a request, and the main station has preset a time gap, allowing the remaining portions to be transmitted all at once without collisions.

It can also be sued as a fixed preallocation. Normally data is sent on the preallocated time gap. When there is a large volume of data, by requesting the main station, it is possible to send excess all at once.

Another major characteristic of the AA/TDMA is that the time gap is variable, permitting optimum transmission efficiency. The automatic error checking and retransmission function can avoid errors in data transmission.

Voice can be transmitted just like data. This voice is a 4.8

kbit/s low rate voice. The voice coding uses the international standard SDM/4 of the international maritime satellite. This type of voice equipment is already in use all around the world.

The ports provided by the NEXTAR AA/TDMA and the satellite network can accomplish the following functions:

(1). Burst TDMA signals into the station and continuous TDMA signals out of the station.

(2). Switch ground agreement into space special agreement in order to reduce satellite time delay.

(3). Use special self-adapting function dynamics to switch station entry mode.

(4). Effectively control of overall flow and distributed flow, preventing overloading from adversely affecting system operations.

(5). Forward error correction to reduce satellite and ground station power requirements.

(6). Possesses network parameter lower line loading capability and flexible network design reconstruction software.

(7). Frequency storage and automatic cut-off functions on reserve relays.

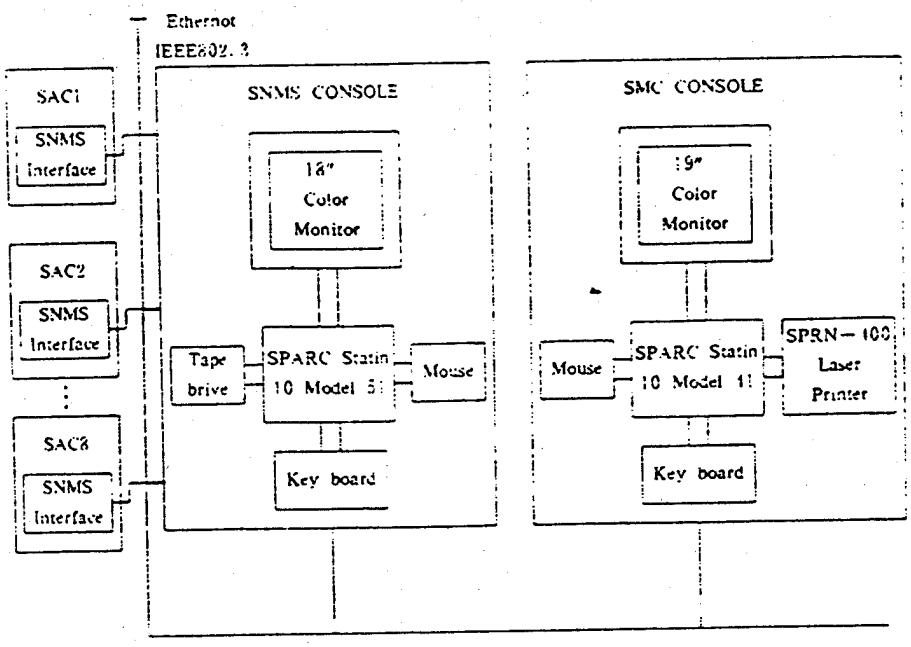
3. Composition

3.1. Hardware structure

The composition of the satellite network management system

SNMS is shown in Figure 2.

Fig. 2. Layout of satellite network management system



Herein, the SNMS monitor and control console is composed of a SPARC STATION 10 MODEL 51 work station with a primary frequency of 45MHz, and a CPU computational speed of 107 MIPS.

The SMC monitor and control console is composed of a SPARC STATION 10 MODEL 41 work station with a primary frequency of 40 MHz, and a CPU computational speed of 96 MIPS.

We can see from the arrangement in the figure that this network management system is a typical Client/Server system. The SNMS is the server. It stores all the source parameters of the entire network. The SNC is the terminal. It is used for specific control of the network.

3.2. Software structure

The operational system of the SNMS is UNIX SUN OS4.1.2, and the data bank uses Eprecs Relation DBMS.

The operational system of the SMC is UNIX SUN OS4.1.2, it was developed using S-WINDOW/Motif.

The network management system software structure can generally be divided into on-line and off-line types. The on-line software is primarily used to control satellite access and for base line processing equipment as well as the central main station control and network structure control. The off-line software can be used for statistical information and for editing output.

4. Network management

VSAT network management can generalized as an administrative management, operational and planning management.

4.1. Administrative management functions

This function allows the operator to take the following actions:

- Add and remove VSAT terminals.
- Add and remove network connections.
- Add and reduce satellite channels (station input and output).
- Design a satellite channel capacity storage for VSAT.
- Start or stop a certain network element.
- Replace network hardware and software.
- Distribute new software.
- Gradually increase network functions and capacity.

Network structure information is retained in the network structure databank. At the same time, it can also be updated there. These databanks determine the overall network's equipment and communications system.

4.1.2. Metering management

Metering management is necessary. This is to calculate the costs of operating the network. These costs are distributed based on the usage of network resources.

4.1.3. Inventory management

This function is used to retain and keep track of the inventory of all equipment in the network including all optional equipment, spare parts and even includes customer equipment in the network connected to VSAT and the main station terminals.

4.1.4. Reliability management

This places different restrictions on managers at different levels to prevent unauthorized access to network resources and management equipment.

4.2. Operations management functions

The primary operations management functions of the VSAT network include:

- Network monitor and control.
- Data collection, filing and report formation.
- Resource access management.
- Error control and flow control.

Each of these functions is very important in order to have effective operations of the VSAT network, no mater what the size of the network.

4.2.1. network monitor and control

The VSAT network requires live time monitor and control, and at the same time possesses command type and cyclical monitor responsibilities. The monitoring of the VSAT network is achieved by using sampling of the various network elements and by using data sampling. It is capable of monitoring the status of substation equipment, main station satellite access equipment SAC (satellite access controller) and the RF equipment. It uses an abnormality detection and informing mechanism, and when performing abnormality checks, it sends abnormality information to the monitoring and control console, using voice frequency alerts to notify the users of abnormalities. Therefore, one of the important functions of the VSAT network monitor and control equipment is to maintain warning and incident monitoring, storage and processing. Incident and warning information processing criterion must be understood by the network operator. All incidents and warnings should be recorded and entered in the warning and incident data bank of the SNMS computer.

The control functions provided by the network management primarily include turning the network on and off, maintaining network resources and diagnostics. Another major function of the monitoring and control subsystem is managing the reserve equipment of the network. The primary station HUB usually constructed in a reserve mode, because the main station going down is the equivalent of the equipment on the entire network going down. The network management system must stay aware of the reserve equipment in the network and of switching them on and off. At the same time, it

must report any change in the states of all connected equipment and reserve equipment. It should prevent switching to reserve equipment which does not exist or which is not in good operating order.

Based on the monitored information, several automatic operations can be used to control access to shared network resources. Similarly, certain manual or semi-automatic operations can also be used to test, evaluate and solve problems. There are also fine adjustments which are made when changes occur.

4.2.2. Data collection, filing and report formation

For effective operation of the VSAT network, data must be collected concerning the network status and properties, and this data must be stored in files. This is necessary for network long-term management, and is especially useful for network expansion design, tendency analysis and network reorganization. The management system must be able to provide formal reports of the VSAT communications capabilities. The specific management system elements in the Shenzhen Securities Satellite Communications System provide statistical reporting capability. This is an extremely important function. In order to constantly improve the operational effectiveness of the network, it is necessary to collect, edit and process the statistical information of the network. This statistical information provides sufficient information and data to assist management personnel in determining the optimum parameters to improve the operational efficiency of the VSAT network and ensure the VSAT network is maintained in the best operational state. The network management equipment can output statistical results as forms and graphics.

The major statistical functions of the SNMS are listed below.

This list of statistical functions is sufficient to illustrate how important the statistical functions are to network management.

SNS statistical functions are in hourly, daily and monthly form.

Note: Outbound refers to information outgoing channels.
Inbound refers to information incoming channels.

Primary statistical items are as follow:

- SAC cumulative operational time.
- Number of SAC malfunctions.
- Number of SAC switch-overs.
- Average dimensions of outbound packages.
- Number of outbound packages.
- Number of REJ frames received by SAC.
- Satellite outbound retransmission rate.
- SAC Channel statistics.
- Inbound error code rate.
- Used time gap data ratio.
- Subscribed time gap data ratio.
- Collision rate.
- Average dimensions of inbound packages.
- Number of inbound packages.
- Average inbound communications volume.
- Average Inbound time delay.
- Statistics on degree of crowding.
- VAST statistics
- VSAT cumulative operational time.
- Number of VSAT malfunctions.
- Inbound retransmission rate.
- SAC/VSAT port statistics.

- Number of inbound data packages.
- Number of outbound data packages.
- Average dimensions of inbound data packages.
- Average dimensions of outbound data packages.
- RF equipment statistics.
- M&C operational time, RF operational time, number of M&C malfunctions, Number of RF malfunctions, total number of RF alerts.
- Number of switch-overs and number of alerts for such RF equipment as LNA, U/C&D/C, and SSPA.

4.2.3. Resource access management

The automatic network monitor and control function provided by the SNMS is related to satellite resources capacity and management. This function is a crowding check function.

Crowding check

In the VSAT network, only the main station is able to monitor the network communications, and at the same time, only successful receipt of data packages is useful for main station capability measurement. The main station success rate in receiving data packages can e reduced by a reduction in sending terminal transmission volume, and can be reduced because of network crowding and data package loss due to data package collisions. These two situations can be separated by using this type of innovative technology.

Each data package sent by the VSAT to the main station has a marker (binary) in front of it. This marker indicates whether this package is a first time transmission or is being retransmitted. At the main station the "package" receival rate (including their indicator) can be determined. An even more precise method of

measuring the status of communications is to increase the number of positions in the package marker to provide the transmission time of this package.

4.2.4. Error control and flow volume control

The determination of the permissible parameters of the SNMS is related to error control and flow volume control.

Error control

Outgoing data transmission errors are detected by the frame check sequence, and the REF frame is requested to be retransmitted to correct the error. On the outgoing circuits, because transmission error rate is low, it is possible to ensure a very high rate of transmission efficiency. The incoming data can have data loss due to collisions, so the error rate is higher. Therefore, selective reject (SREJ) error correction control is necessary to prevent a drop in transmission efficiency. Because of the occurrence of collisions, changes may occur in incoming data sequence. Error control also has the capability of restoring the proper data sequence.

Flow volume control

It is especially important to control the inbound data flow in order to prevent system instability because of increased data collisions. In this AA/TDMA system a dual data control system is used, the inbound VSAT dispersed data flow control and the central main station concentrated data flow control.

The VSAT dispersed data flow control

When a collision occurs in data send from any VSAT station, the VSAT station dispersed data flow control will first evaluate the channel confusion, and then exercise control over the data flow. Before it is ascertained that the retransmitted data has been sent, new data transmission by random multiple address mode is controlled, and switched-over to subscriber mode to send data. This mode can continue until the retransmitted data send signal has been verified. If the retransmitted data is verified as sent, then it is possible to return to the original random multiple address mode and subscriber mode for transmission.

Concentrated data flow control

In order to exercise concentrated control over data flow the central station monitors the blockages of the overall network, depending on the number of data retransmissions of each station, and depending on the statistical situation. When the number of data retransmissions exceeds a certain value, the SNMS will judge the network to be blocked, and at this time the main station will use the broadcast mode to send instructions to each VSAT station to extend the time gap between data retransmissions. When the main station sends this instructions, the VSAT station will lengthen the time it waits after recognizing data loss to retransmitting the data, resulting in controlling random address data transmission rate. If the network continues to become more blocked, the main station will send instructions to all VSAT stations to stop sending new data.

4.3. Planning management functions

This function is a method of optimizing the VSAT network. This optimization is focussed on network optimization of designed and measured communications channels. Although planning functions

basically exceed the scope of the network management system, but it is especially important for the plan to proceed. The system provides the network administrative and management personnel and network planning personnel with sufficient operational information. The two basic portions of VSAT network planning are the negative loading balance and resource planning. Here it is necessary to analyze, and is necessary to simulate equipment. In summary, the VSAT network's network management is an important part of the overall system design. There are many network management functions and requirements. The technology involved concerns a number of fields such as communications and computer technology. Network management affects almost every aspect of the VSAT network implementation, operation and maintenance.

5. Conclusion

The VSAT is satellite communications technology which was developed in the eighties. It represents a major direction in the development of satellite communications. It is widely used in various fields of the national economy and it has an excellent future. The establishment of the Shenzhou Securities Satellite Communications Network has done a great deal towards alleviating the shortage of communications channels of the Shenzhen stock market, towards increasing stock market activity, and it has achieved excellent social and economic benefits. Through its description of the VSAT key components, network management functions and technical characteristics will help engineering and technical personnel to have a more thorough understanding of VSAT technology.

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About the author

Han Peng is 31 years old. He holds a bachelors degree in engineering. He has participated in the computer system design research work for a number of oil field automation projects in China. In April of 1993 he began participating the system analysis, system design and installation of the Shenzhen Securities Satellite Communications System. He is the responsible person of the network management subsystem.